ACTION AGENDA:

Connectivity-Informed MPAs and MPA Networks for Effective Marine Conservation and for Meeting the Challenges of Climate Change in the Marine Environment

Marine Protected Areas Federal Advisory Committee

January 2017

Introduction

In April 2015, the Marine Protected Areas Federal Advisory Committee (MPA FAC) was charged with advising the United States Secretaries of Commerce and Interior on incorporating knowledge about ecological spatial connectivity ("ecological spatial connectivity" or "connectivity") and climate change into the design, use, and management of effective marine protected areas ("MPAs") and MPA networks. Incorporating knowledge about connectivity into MPAs and MPA networks is essential for achieving goals of conserving marine populations and ecosystems. In addition, incorporating knowledge about connectivity best equips MPAs and MPA networks to achieve conservation goals as the marine environment undergoes significant changes due to climate change.[1]

In response to the charge, the MPA FAC produced this Action Agenda, along with a Scientific Synthesis.[2] The Action Agenda sets forth the MPA FAC's Recommendations; the Scientific Synthesis -- The Central Importance of Ecological Spatial Connectivity to Effective Marine Protected Areas and to Meeting the Challenges of Climate Change in the Marine Environment -- complements the Action Agenda by providing a summary of key scientific information about ecological spatial connectivity and marine protected areas. The MPA FAC used the information in the Scientific Synthesis, along with MPA FAC members' additional expertise and experience concerning MPAs, to create the Action Agenda. Both the Action Agenda and the Scientific Synthesis build on prior work and recommendations of the MPA FAC on the topic of climate change and MPAs.[3]

This Action Agenda contains, in addition to the Recommendations to the Secretaries, a set of universal guidelines for enhancing connectivity in MPAs and meeting the challenge of climate change in the marine environment: the MPA FAC Guidelines for Enhancing Effectiveness, Connectivity, and Resilience

[1] See Appendix 1 for a Glossary of Key Terms.

[2] For composition of the MPA FAC and of the MPA FAC Connectivity Subcommittee, which prepared the Scientific Synthesis and the Action Agenda for the MPA FAC, please see Appendix 2.

[3] In April 2010, the MPA FAC issued "Climate Change in The Ocean: Implications and Recommendations for the National System of Marine Protected Areas"; see http://marineprotectedareas.noaa.gov/fac/products/ (2010 products). In connection with this set of Recommendations, an MPA FAC subcommittee - the MPA FAC Scientific and Technical Subcommittee - produced a technical background document entitled "Climate Change Impacts on Coastal and Marine Ecosystems and the Potential Role of the National System of MPAs: A Primer and Guide for Members of the Marine Protected Areas Federal Advisory Committee"; see http://marineprotectedareas.noaa.gov/fac/products/fac-climate-background-042010.pdf (2010 background paper).

in MPAs and MPA Networks. Several of the MPA FAC's Recommendations rely on and incorporate the MPA FAC Guidelines. The Guidelines, like the Recommendations, are based in part on the Scientific Synthesis (and on the MPA FAC's prior work and recommendations).

As the Secretaries of Commerce and Interior, you have jurisdiction over, and responsibility for, the majority of federal MPAs in US waters, and you play an important leadership role for MPAs throughout the nation. By carrying out the Recommendations in this Action Agenda, you will significantly enhance connectivity in, around, and among these important ocean areas. This will strengthen our nation's MPAs and MPA networks and make them more effective in the face of a changing marine environment.

In what follows, we present: (1) a review of key points about connectivity, climate change, and MPAs (taken from the Scientific Synthesis); (2) our Recommendations; (3) our Guidelines; and (4) a brief conclusion.

Key Points from the Scientific Synthesis: MPAs in a Connected and Changing Marine Environment

Ecological spatial connectivity has profound implications for the conservation of marine populations, communities and ecosystems, and for the role, design and effectiveness of MPAs and MPA networks as conservation and management tools in the face of a changing global climate. Chief among these are:

- The several forms of spatial ecological connectivity – population, genetic, community, ecosystem - are among the most important ecological processes in determining the distribution, persistence, and productivity of marine populations and ecosystems.
- For most marine organisms, population connectivity is achieved through the dispersal of young (larvae, algal spores) by ocean currents. Levels of connectivity are often high among marine populations and ecosystems because of the ability of currents to transport organisms, nutrients, and material (e.g., sediments) between distant areas.
- High spatial connectivity among distant ecosystems means that populations and ecosystems within MPAs can help replenish populations in, and provide material subsidies (e.g., nutrients) to, ecosystems beyond their borders. This same connectivity also increases the reliance of populations and ecosystems within a given MPA on delivery of young and subsidies from populations and ecosystems beyond that MPA's borders. It also increases MPAs' vulnerability to influxes of detrimental organisms (e.g., invasive species) and materials (e.g., sedimentation, eutrophication, pollutants) from outside their boundaries.
- Networks of MPAs linked ecologically through larval connectivity enhance the likelihood of replenishment of populations and communities across the network of MPAs and, also, importantly, in ecosystems outside the borders of the MPAs constituting the network. In addition, MPAs that encompass multiple ecosystems increase the strength of ecosystem connectivity, including the movement of individuals between ecosystems over their lifetime and the subsidies transferred from one ecosystem to another.
- The sound management of human uses of marine populations (e.g., fisheries, introduced species) and ecosystems (e.g., nutrient and sediment control) outside of MPAs is critical to MPAs' effectiveness for the conservation and management of marine populations and ecosystems.
- Climate change is altering the distribution, size and productivity of populations and the extent, composition and productivity of ecosystems, including those within MPAs. These climate change impacts can be exacerbated by other, more direct, local human impacts on marine populations

and ecosystems. Thus, the protections afforded by MPAs from direct, local human impacts may ameliorate climate change impacts in ecosystems inside MPAs and, also, indirectly, in ecosystems outside MPAs (through larval dispersal from within the MPAs). Networks of MPAs that encompass populations and ecosystems across a region may facilitate the redistribution and persistence of populations and ecosystems in response to climate change and protect those more likely to withstand changing environments.

Recommendations to the Secretaries of Commerce and the Interior

While US MPAs have a wide range of objectives, a great many US MPAs are ecological MPAs, i.e., intended to restore or maintain ecological phenomena in the marine environment - populations, communities, ecosystems, and processes. All ecological MPAs - no matter their specific ecological focus, no matter their specific objectives - depend for their success on incorporation of knowledge about ecological spatial connectivity into their design, use, and management. Recent research increasingly highlights the importance of ecological spatial connectivity for populations, ecological communities, and ecosystems in the marine environment. Connectivity is also recommended as a key design element of MPA networks by IUCN and the Convention on Biological Diversity.[4]

Yet, most U.S. MPAs were created with a singular focus on reducing localized human threats and enhancing ecological communities *within their boundaries* (we refer here, and throughout, to ecological MPAs). Very few MPAs were explicitly designed in consideration of their broader ecological spatial context. And very few MPAs were designed as components of an integrated, ecologically connected *network* of protected areas functionally linked together and to surrounding ecosystems by the current-driven movement of larvae, juveniles, adults, food, and other important materials.[5] In addition, most of those MPAs were established before it was understood that climate change in the marine environment produces significant changes in the distributions, abundances, and productivities of marine species and in so doing produces significant changes to marine ecosystems.

With proactive action by ocean agencies and MPA managers, MPAs can be more effective conservation tools. By enhancing ecological connections among sites and creating an integrated network of ecologically linked MPAs, these places and the intervening areas around them can also be more resilient to the impacts of climate change. Fortunately, we possess the knowledge and the tools right now to meet this pressing challenge, if we act soon. As the Secretaries of Commerce and Interior, you have jurisdiction over, and responsibility for, the majority of federal MPAs and you play an important leadership role for MPAs throughout the nation. For these reasons, the MPA FAC recommends that you:

A. *Begin immediately to strengthen the effectiveness and resilience of all MPAs within your respective jurisdictions by enhancing ecological spatial connectivity, using the MPA FAC Guidelines for Enhancing Effectiveness, Connectivity and Resilience in MPAs and MPA Networks ("MPA FAC Guidelines").*

---

[4] See IUCN-WCPA, *Establishing Marine Protected Area Networks—Making It Happen*, p. 52 (2008), available at https://cmsdata.iucn.org/downloads/mpanetworksmakingithappen_en.pdf and CBD et al, Azores Scientific Criteria and Guidance, p. 10 (2009), available at https://www.cbd.int/marine/doc/azores-brochure-en.pdf.

[5] California's network of MPAs created recently through the Marine Life Protection Act process represents the nation's best current example of a designed, connected network. See https://www.wildlife.ca.gov/conservation/marine/MPAS#40713403-mlpa.

B. *Urge and aid other MPA agencies and programs (in the federal government and in state, tribal, territorial, and local governments) to enhance connectivity in, around, and among their MPAs, using the MPA FAC Guidelines.*

C. *Develop Secretarial-level guidance, resources and expectations for implementing the MPA FAC Guidelines. Distribute the MPA FAC Guidelines, together with the MPA FAC's Scientific Synthesis, to MPA agencies and programs at all levels of government throughout the nation.*

D. *Use governmental and academic experts to develop measures of connectivity among areas and within key species populations. Make these measures available to MPA agencies and programs at all levels of government throughout the nation.*

E. *Lead efforts to ensure funding and capacity for monitoring, evaluation, and adaptive management of MPAs and MPA networks. Lead efforts to develop best practices for adaptive management in MPAs and MPA networks, and charge the MPA FAC with convening a working group on adaptive management.*

F. *Improve collaboration across the Departments of Commerce and Interior by ensuring that all key offices in the Departments leverage expertise, resources, and efforts*.

In support of these Recommendations and for any agency or program charged with managing, implementing or creating MPAs, we offer the following detailed guidelines for enhancing effectiveness, connectivity, and resilience in MPAs and MPA networks:

MPA FAC Guidelines for Enhancing Effectiveness, Connectivity and Resilience in MPAs and MPA Networks

Use Existing Scientific and Traditional Knowledge about Connectivity

a) Build a Connectivity Roadmap**.** Determine how local ecosystems, communities and populations of key species are linked by ecological spatial connectivity (e.g., the spatial distribution, timing, predictability, and impacts of important connectivity processes among populations and ecosystems inside MPAs and in surrounding areas).

b) Examine External Inputs**.** Consider whether ecosystems and ecological communities outside of MPAs can serve as sources of beneficial recruits or harmful materials into nearby MPAs, and how various approaches to management of human impacts in those intervening ecosystems can, in turn, help sustain viable populations, communities and ecosystems within MPAs and the services they provide.

c) Evaluate Climate Change Impacts**.** Assess how climate change may alter important environmental and oceanographic drivers of connectivity (e.g. currents, winds, temperature, acidification), and how the resulting environmental changes may impact the populations, communities and ecosystems they connect, both inside and outside MPAs (e.g. range shifts, source-sink dynamics, asynchrony in life history stages and trophic interactions).

d) Synthesize, Share, and Build on Existing Knowledge. Use existing scientific and traditional knowledge to take action now *and* to build additional knowledge.

e) Evaluate What's Needed. Determine—from a scientific perspective—how connectivity can be enhanced to improve the effectiveness of MPA and/or MPA network design and management, especially in the face of climate change.

f) Engage Experts. Collaborate with external expertise in academia, industry and elsewhere to inform all of the above efforts.

II. Enhance Connectivity and Resilience in Existing MPAs

Informed by the above information, these agency actions can enhance effectiveness of an existing MPA, whether or not the MPA is part of an integrated network of sites.

a) Act Inside the Box: Sustain viable populations, communities, and ecosystems within the MPA by ensuring that management measures adequately address threats posed by human activities within the boundaries. Prioritize management actions that enhance the site's output of key species to external ecosystems via the dispersal of young or the migration of adults.

b) Act Outside the Box: Optimize Beneficial Inputs. Collaborate with relevant agencies to manage adjacent ecosystems and populations outside the MPA in ways that optimize their contribution of key species into the MPA via the current-driven dispersal of young or the active migration of adults.

c) Act Way Outside the Box: Minimize Harmful Inputs. Collaborate with relevant land and ocean agencies to reduce the influx of harmful materials (e.g. polluted runoff, anthropogenic noise, invasive species) emanating from marine and terrestrial ecosystems beyond the MPA's boundaries.

d) Evaluate Legal and Policy Tools. Consider what tools exist to leverage and enhance connectivity in marine ecosystems.

e) Evaluate Additional or Modified MPA Coverage. Evaluate the need to expand or modify existing MPA boundaries to ensure that they protect ecologically important habitats and populations critical to sustaining local ecosystems in the site, as well as their connectivity-driven contributions to distant MPAs and other areas.

f) Use Adaptive Management Principles. Conduct regular monitoring of MPA ecosystems and connectivity processes, and use the results to objectively evaluate the effectiveness of current management approaches as well as to inform needed modifications (e.g. protections, boundaries) to adapt to changing conditions (e.g. climate change impacts).

g) Coordinate with Other Agencies. Actively engage other place-based management agencies to leverage the site's local actions toward broader common goals, including sustaining and enhancing connectivity among and beyond MPAs. Where relevant, build transboundary relationships to aid management.

h) Collaborate with Other Levels of Government. Work among and between agencies and programs of the federal government, states, tribes, territories, localities and with the National Ocean Policy Regional Planning Bodies to advance connectivity among MPAs and MPA networks.

i) Use the MPA FAC Scientific Synthesis: Consult the MPA FAC's Scientific Synthesis: The Central Importance of Ecological Spatial Connectivity to Effective Marine Protected Areas and to Meeting the Challenge of Climate Change in the Marine Environment. Review the paper for additional design, use, and management principles for enhancing connectivity processes within, around, and among MPAs and MPA networks.

j) Use Best Practices and Follow all Statutory and Regulatory Requirements: Ensure that any adjustments to MPA rules or boundaries follow best practices for managing and modifying MPAs

and follow all relevant statutory and regulatory requirements. Use the MPA FAC's "Guiding Principles for Marine Protected Areas that Can Help Support Healthy Coastal Communities."[6]

III. Create Resilient MPAs and MPA Networks

Building from the above actions (Sections I & II), this section provides guidance for agencies and programs developing new or expanded networks of MPAs that are specifically designed to enhance connectivity across the network and, therefore, to confer increased resilience among its component sites to the impacts of climate change.

a) Start Here. Build from the guidelines identified in Section I (a)-(f) and Section II (a)-(j).

b) Anticipate Climate Impacts. Based on the information described in Section I above, evaluate the potential impacts of climate change to ecosystems and species of interest, and assess the adequacy of existing place-based management measures to address those threats.

c) Use Critical Design Principles. Ensure that the design of new MPAs and networks incorporates important ecological features and processes, including: (i) multiple marine ecosystems within individual sites and across the entire network; (ii) areas important to different life history stages of key species (e.g. spawning grounds); (iii) spacing of MPAs to ensure population, community and ecosystem connectivity based on larval dispersal; (iv) areas that provide sufficient genetic diversity, especially for key species, to ensure their persistence and resilience to climate change; and, (v) habitats that support and export economically important species (e.g. fished stocks) by the emigration of young and adults from the MPAs into other areas where they may be harvested. See also II (i).

d) Build MPA Stepping Stones. Design and site new MPAs in ecologically connected similar habitats likely to provide critical linkages for key species' populations extending their geographic range in response to climate change.

e) Replicate. Establish, where feasible, multiple, ecologically linked MPAs for each major ecosystem or community type to be conserved to provide a buffer against unpredictable environmental changes or catastrophes.

f) Use Adaptive Management Principles. Ensure regular monitoring of any new MPAs or MPA networks and use the results to objectively evaluate the effectiveness of management approaches as well as to inform needed modifications (e.g. protections, boundaries) to adapt to changing conditions (e.g. climate change impacts).

g) Use Best Practices and Follow all Statutory and Regulatory Requirements: Ensure that the creation of any new MPAs and MPA networks follows best practices and all relevant statutory and regulatory requirements. Use the MPA FAC's "Guiding Principles for Marine Protected Areas that Can Help Support Healthy Coastal Communities."[7]

---

[6] These are contained in the Committee Recommendations on Marine Protected Areas and Healthy Coastal Communities (December 2011), which is at http://marineprotectedareas.noaa.gov/fac/products/ .

[7] These are contained in the Committee Recommendations on Marine Protected Areas and Healthy Coastal Communities (December 2011), which is at http://marineprotectedareas.noaa.gov/fac/products/ .

h) Use MPAs to Inform Ocean Management. Where possible, use existing MPAs and MPA networks, or design new MPAs and MPA networks specifically to provide crucial and scientifically robust insight to ocean management agencies about the status and trends of species and areas of interest, particularly in relation to the impacts of climate change.

Conclusion

As the Secretaries of Commerce and Interior, you have the power to make our MPAs more effective conservation tools and resilient to the effects of climate change in the marine environment. By carrying out the recommendations in this Action Agenda, you will significantly enhance connectivity in, around, and among MPAs. This will strengthen our nation's MPAs and MPA networks and make them more effective in the face of a changing marine environment.

APPENDIX 1: Glossary

adaptive management – a structured, iterative process of monitoring, evaluation, and management decisions in the face of uncertainty. Adaptive management in MPAs and MPA networks consists of monitoring and evaluation, and, as needed, changes in management measures in an existing MPA, including regulatory and boundary changes, and the addition or removal of MPAs in a network. Adaptive management depends on clear articulation of the specific conservation purposes of the MPA or MPA network, so that protocols for monitoring can be properly designed and so that effectiveness of the MPA or MPA network can be measured against specific, articulated aims.

connectivity-informed MPA or MPA network – an MPA or network of MPAs designed, used, and managed to foster the ecological spatial connectivity processes important to the populations, species, communities, and/or ecosystems of concern in the MPA or network of MPAs.

community connectivity – the transfer of species between ecological communities resulting from the movement of one or more species among spatially separated ecological communities.

ecological community – the collection of species that co-occur and interact with one another in a particular habitat (e.g., a coral reef, kelp forest or seagrass bed).

ecological MPA - an MPA that focuses on restoring or maintaining ecological phenomena in the marine environment, i.e., populations, species, ecological communities, ecosystems or processes.

ecological spatial connectivity – the transfer of genes, organisms, species, materials (e.g., sediment), chemicals (e.g., nutrients), or energy (ecosystem connectivity) resulting from their movement among spatially separated populations, communities or ecosystems.

ecosystem – the biotic (i.e. organisms) and abiotic (i.e. physical and chemical) components of an environment that interact with one another, including species, geological features and oceanographic features (e.g., water currents, chemistry).

ecosystem connectivity – the transfer of species, chemicals (e.g., nutrients and pollutants), energy (in the form of organisms), and materials (e.g., sediments and debris) between ecosystems, resulting from their movement between spatially separated ecosystems.

genetic connectivity – the transfer of genes among populations of a species (also called “gene flow”), resulting from the movement of organisms between spatially separated local populations, whether spores of marine algae or the larvae, juveniles or adults of marine animals.

habitat – biotic and abiotic elements of the environment used by an organism.

marine environment - "'Marine environment’ means those areas of coastal and ocean waters, the Great Lakes and their connecting waters, and submerged lands thereunder, over which the

United States exercises jurisdiction, consistent with international law" (Exec. Order 13158: 2000). "Marine environment" includes "intertidal areas, bays or estuaries" (MPA Center 2015:10).

metacommunity – A collection of spatially separated communities that are connected to each other by the movement of species (i.e. by community connectivity).

metapopulation – A collection of spatially separated local or sub-populations of a species that are connected to each other by the movement of individuals of that species (i.e. by population connectivity).

population – A collection of individuals of the same species that co-occur in space and time and interact with one another.

population connectivity – The transfer of individuals among populations of a species resulting from the movement of individuals (spores, larvae, juveniles or adults) of a single species among spatially separated local or sub-populations.

resilience – The internal capacity of a system (e.g., organism, population, ecological community, human community, ecosystem, institution) to return to its original state or condition subsequent to a perturbation.

resistance – The internal capacity of a system (e.g., organism, population, ecological community, human community, ecosystem, institution) to resist change in the face of perturbation.

sink population – A local or subpopulation within a metapopulation that receives more individuals (spores, larvae, juveniles or adults) than it contributes to other subpopulations in the metapopulation.

source population – A local or subpopulation within a metapopulation that contributes more individuals (spores, larvae, juveniles or adults to other subpopulations) than it receives from other subpopulations in the metapopulation.

US MPAs - MPAs created and maintained by federal, state, tribal, territorial, or local authorities in the United States. US MPAs include federal MPAs but are not limited to federal MPAs.

APPENDIX 2: Membership of MPA Federal Advisory Committee and the MPA FAC Connectivity Subcommittee

MPA FAC:

George J. Geiger, Chair (2009-2016)
Della Scott-Ireton, Ph.D., Vice-Chair (2009-2016)
Brian Baird (2014-2018)
Rick Bellavance (2014-2018)
Mark Carr, Ph.D. (2014-2018)
Gary Davis (2009-2016)
Martha Honey, Ph.D. (2014-2018)
John Jensen, Ph.D. (2011-2016)
Stephen Kroll (2011-2016)
Stephanie Madsen (2014-2018)
Samantha Murray, J.D. (2014-2018)
Ryan Orgera, Ph.D. (2014-2018)
Jason Patlis, J.D. (2011-2016)
Catherine Reheis-Boyd (2011-2016)
Sarah Robinson, J.D., S.J.D. (2009-2016)
Ervin Joe Schumacker (2009-2016)
Peter Stauffer (2014-2018)
Trisha Kehaulani Watson, J.D., Ph.D. (2014-2018)
Stephen Welch (2011-2016)
Margaret Williams (2014-2018)

See http://marineprotectedareas.noaa.gov/fac/membership/ for more information.

MPA FAC Connectivity Subcommittee (2015-2016):

Mark Carr, Ph.D., Co-Chair
Sarah Robinson, J.D., S.J.D., Co-Chair
Gary Davis
Stephen Kroll
Samantha Murray, J.D.
Ervin Joe Schumacker
Margaret Williams

Charles Wahle, Ph.D., National MPA Center staff liaison to Connectivity Subcommittee